Evaluating Pumping and Drawdown Scenarios

What's the issue?

As the world population continues to grow, more people than ever before are living in and around cities. Today, over half of the world lives in urban areas and two thirds of the world will by 2050. In Wisconsin, this global trend is evident near Milwaukee, Madison, and Green Bay. Between 1980 and 2010, the population in Waukesha, Dane, and Brown counties increased by over 40% – more than double the statewide rate of population increase.

Changes in where people live leads to changes in the distribution and amount of groundwater pumped from aquifers to support homes and businesses. In southeastern Wisconsin as well as in the Lower Fox Valley near Green Bay, groundwater demands lowered the water table by several hundred feet over the past few decades. In the Madison area, drawdowns have been around 50 feet.

As population increase in urban areas, so does the demand for public water supply from distribution systems in cities like Milwaukee, Madison (pictured), and Green Bay. *Photo: David Nevala for UW Water Resources Institute*.

Wisconsin's urban centers are not the only places experiencing dramatic drawdowns. About 20% of the state's groundwater pumping occurs in the Central Sands region, predominately for irrigation. While wells in Wisconsin's urban areas typically draw from confined aquifers not well connected to surface waters, wells in the Central Sands draw from an unconfined aquifer that is a critical source of water for lakes, streams, and wetlands in the area.

Wisconsin is water-rich overall, but these long-term drops in groundwater levels can create local scarcity in water resources. Drawdowns can cause the water level in wells, lakes, streams and wetlands to drop or dry up entirely. Additionally, water level declines can trigger geochemical reactions that cause the levels of arsenic, radium, and salinity in drinking water to increase. These consequences of long-term drawdown have a serious impact on the environment, economy, and public health.

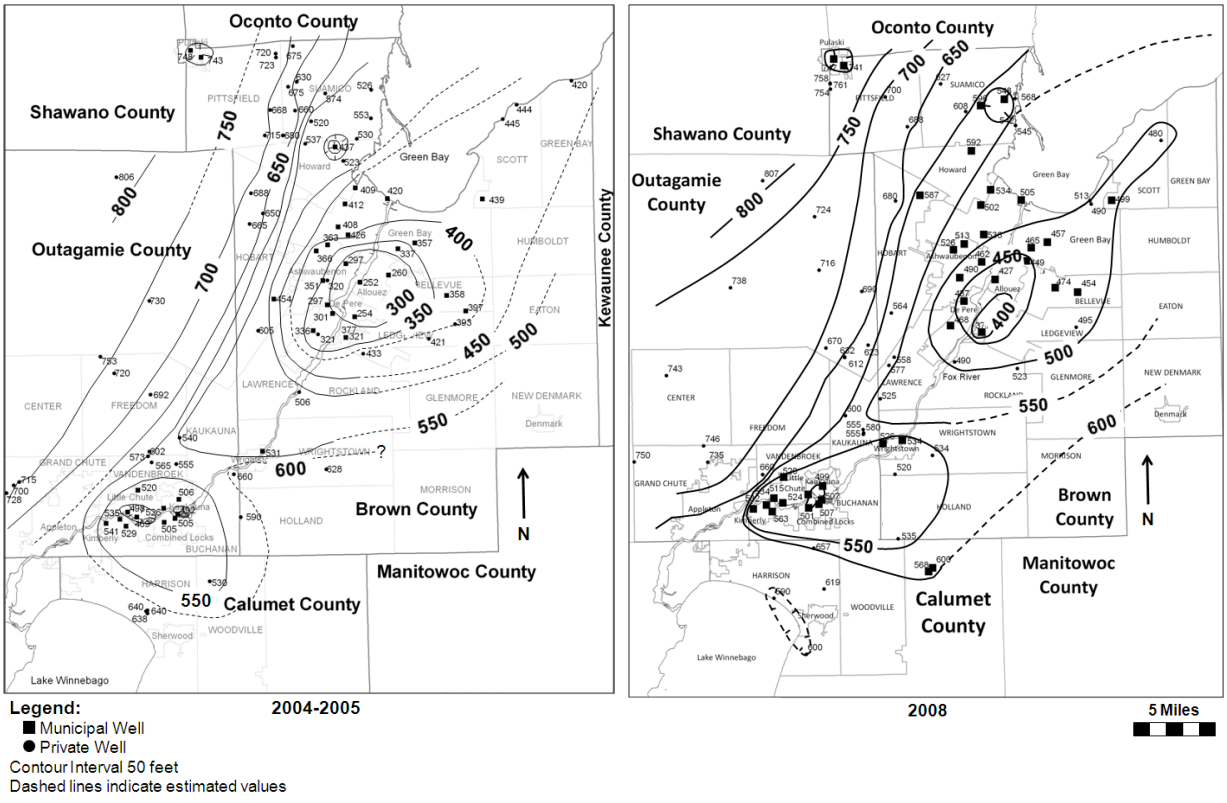
GCC in Action: *Green Bay Recovery*

Due to concerns about the magnitude of drawdown in recent decades, the Lower Fox River Valley near Green Bay was labeled a Groundwater Management Area under Act 310 in 2003. The intent of this designation is to encourage a coordinated management strategy among the state, local government units, regional planning commissions, and public and private users of groundwater to address the problems caused by overpumping the deep aquifer. To facilitate management, GCC agencies assisted these stakeholders by undertaking research and planning related to groundwater management. GCC projects in the Lower Fox River Valley have notably improved our understanding of groundwater flow

patterns, high salinity, high arsenic, and increasing radium in the area (Grundl, 2000; Grundl and Schmidt, 2002; Gotkowitz et al., 2003; Hooyer et al., 2007 and 2008).

In response to groundwater quantity and quality issues in the Lower Fox Valley, eight suburban communities near Green Bay reduced consumption of groundwater in 2007 by switching to surface water supplied by pipeline from Lake Michigan. This created a unique opportunity to observe changes in water levels due to *decreases* in pumping rates, rather than increases.

The effect of the switch was rapid and remarkable, as demonstrated by researchers at UW and WGNHS funded by the Wisconsin Groundwater Research and Monitoring Program (WGRMP) (Luczaj et al., 2009). Within the first two years, groundwater levels in the deep confined sandstone aquifer rose by over 100 feet in areas that had experienced the greatest drawdown. Today, rates have tapered off but groundwater levels in the deep aquifer continue to rise slowly. In some cases, these levels have risen above the surface, creating flowing wells and a need to deal with excess water. At the same time, a small region of the Groundwater Management Area centered in the southeastern corner of Outagamie County has remained unaffected by the decreased pumping to the north – the cone of depression around Little Chute, Kaukauna, and Kimberly has not experienced any notable improvement.



Pumping withdrawals and water table levels (in feet above mean sea level) before and after reduction in pumping. Groundwater levels rose over 100 feet in the cone of depression near Green Bay. *Figure: John Luczaj*

This research illustrates the importance of monitoring the resource after key groundwater management decisions. Because of these projects, we now know that the pumping in southeast Outagamie does not

impact the cone of depression closer to Green Bay. We also know that a further decrease in pumping in the Green Bay area will cause more wells to flow above the surface in the communities northwest of Green Bay. Yet as long as pumping rates remain near their current levels, the higher water table may reduce the risk of arsenic and radium release. Each of these conclusions helps GCC agencies and stakeholders better understand which management decisions are likely to have a positive effect on groundwater supply and groundwater quality for the people, businesses, and environment of Wisconsin.

Other Projects in Other Places

Southeastern Wisconsin is also designated as a Groundwater Management Area under Act 310. As in the Lower Fox Valley, WGRMP-funded research has advanced our understanding of the geology, hydrology, and geochemical conditions contributing to similar groundwater issues in this region (Cherkauer and LaCosse, 2003; Grundl et al., 2003; Skalback et al., 2008). One of the biggest concerns for the southeastern communities is the increasing concentration of radium with drawdown, also a focus of WGRMP-funded studies (e.g., Grundl, 2000). Several communities are facing a regulatory deadline related to radium and must look for alternate drinking water sources. The main surface water alternative is Lake Michigan, but use of this water outside the Great Lakes Basin requires approval from all of the other Great Lakes states, as well as Canadian provinces. The city of Waukesha applied for this option in 2011 and the Compact Council made an unprecedented decision to approve Waukesha's application (with conditions) in 2016. All alternatives to the deep aquifer have their own obstacles and challenges, but as more communities opt to avoid it in favor of sources with lower concentrations of radium, water table declines have leveled off and are starting to recover in some wells.

In the *Central Sands*, the study of groundwater flow and its complex interactions with stream flows and lake levels dates back to historical experiments [video link] by the USGS, WGNHS, and the Wisconsin Conservation Department (precursor to the DNR) in the 1960s. Decades of continued study by GCC agencies and GCC-supported researchers, all summarized in a recent white paper, have further described the hydrogeology, climatology, and impacts of groundwater pumping on lakes, rivers, and wetlands in this region (Kniffen et al., 2014). This research, specific to the Little Plover River watershed, confirms that the Little Plover River is closely connected to the groundwater system, making it vulnerable to impacts from nearby high capacity well groundwater withdrawals.

The Little Plover River, the site of decades of research on the links between groundwater stress and surface water response. *Photo: David Nevala for UW Water Resources Institute.*

Since 2013, GCC agencies including the DNR, WGNHS, UW Extension, and the USGS have worked to bring stakeholders together in support of a new state-of-the-art groundwater flow model that builds on

past modeling to assess current conditions and evaluate potential solutions. The Wisconsin Potato and Vegetable Growers Association Groundwater Task Force, an initiative of the agricultural industry in cooperation with members of GCC agencies, has been a strong supporter of this work. This project has all the hallmarks of a classic GCC initiative: GCC agencies collaborating on cutting edge science and building on decades of knowledge in order to provide information that communities can use to solve problems.

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